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TI Lead-free solder of tin-aluminum-indium-silver alloy for low temperature use  
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PI	JP 2000141078	A	20000523	JP 1999-54716	19990302
PRAI	JP 1998-253852	A	19980908		
AB	The solder of Sn alloy contains Al 0.01-3.0, In 0.1-50, Ag 0.1-6.0, Cu 0-6.0, and Zn 0-10.0%. Oxide materials, e.g., glasses, ceramics, can be strongly bonded with the solder.				

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**Notes:**

1. Untranslatable words are replaced with asterisks (\*\*\*\*).
2. Texts in the figures are not translated and shown as it is.

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**FULL CONTENTS**

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**[Claim(s)]**

[Claim 1] Unleaded pewter characterized by displaying by weight % and 0.01 to 3.0% of aluminum, 0.1 to 50% of In, 0.1 to 6.0% of Ag, 0 to 6.0% of Cu, 0 to 10.0% of Zn, and the remainder consisting of Sn.

[Claim 2] Unleaded pewter according to claim 1 which displays by weight % and contains 0.01 to 1.0% of aluminum.

[Claim 3] Unleaded pewter according to claim 1 or 2 which displays by weight % and contains 0.1 to 30% of In.

[Claim 4] Unleaded pewter according to claim 1 to 3 which displays by weight % and contains 0.1 to 3.5% of Ag.

[Claim 5] Unleaded pewter according to claim 1 to 4 which displays by weight % and contains 0.1 to 1.0% of Cu by a percentage by weight.

[Claim 6] Unleaded pewter according to claim 1 to 5 which displays by weight % and contains 0.01 to 7.0% of Zn.

[Claim 7] Unleaded pewter according to claim 1 to 6 which contains one or more kinds of elements which display by weight % and are chosen from among Sb, Ti, and Si or Bi in a total of 10% or less of range.

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**[Detailed Description of the Invention]**

[0001]

[Field of the Invention] This invention relates to unleaded pewter for oxide material junction of

Ceramics Sub-Division which can work at low temperature, glass, etc.

[0002]

[Description of the Prior Art] Although the method of performing electroplating and electroless deposition, such as gold plate, copper plating, and a nickel plate, beforehand for soldering of oxide material, such as Ceramics Sub-Division and glass, is common knowledge conventionally, To solder at an expensive price [ soldering to a plating side ], intricately, and more economically is demanded.

[0003] It is indicated by glass and Ceramics Sub-Division about the Pb-Sn system pewter which can carry out direct soldering at JP,S49-22299,B or JP,S52-21980,B in order to meet this request.

[0004] However, lead is a strong toxic metal, we are anxious about the influence of the health and environment on leaden, the bad influence to an ecosystem and contamination are being regarded as questionable, and the motion which makes pewter unleaded is spreading quickly in recent years.

[0005]

[Problem(s) to be Solved by the Invention] [ pewter / material /, such as glass and Ceramics Sub-Division, / oxide film ] although the pewter currently indicated by above-mentioned JP,S49-22299,B is Pb-Sn-Cd-Sb pewter which can be soldered direct Since this pewter contains lead of a toxic substance, if the waste of the product using these pewter is exposed to acid rain, lead will be eluted in large quantities, and that toxicity poses a very serious problem.

[0006] Moreover, although the pewter indicated by above-mentioned JP,S52-21980,B is rare earth metal content pewter usable to junction of oxide material, such as glass and Ceramics Sub-Division, the main ingredients are lead and this pewter also has the same problem.

[0007] On the other hand as unleaded pewter, research is mainly briskly made as an object for electronic-parts mounting. For example, although it is indicated by JP,H9-326554,A about Sn-Ag-In pewter and indicated by JP,H8-164495,A about Sn-Zn-Bi pewter All have the trouble that the junction intensity of pewter is not enough, in soldering to oxide material, such as glass and Ceramics Sub-Division.

[0008] Furthermore, although indicated by JP,S55-36032,B about Sn-Ag-aluminum-Zn pewter to the metal oxide as unleaded pewter which can be soldered, for example Since metal is chosen as a zygote, when it is used to oxide material which a coefficient of thermal expansion is large and is different, such as glass and Ceramics Sub-Division, it has the trouble of being easy to exfoliate.

[0009] This invention is made in view of the above-mentioned conventional actual condition, and it aims at offering the unleaded pewter which has sufficient junction intensity to oxide material, such as glass and Ceramics Sub-Division, excluding lead of a toxic substance.

[0010]

[Means for Solving the Problem] This invention is made in order to join oxides, such as glass and Ceramics Sub-Division, and it is considered as the composition which contains aluminum, In, Ag, Cu, and Zn in the pewter which makes Sn the main ingredients.

[0011] That is, it is characterized by displaying unleaded pewter of this invention by weight %, and 0.01 to 3.0% of aluminum, 0.1 to 50% of In, 0.1 to 6.0% of Ag, 0 to 6.0% of Cu, 0 to 10.0% of Zn, and the remainder consisting of Sn.

[0012] Here, as for unleaded pewter of this invention, it is desirable as the component to contain 0.01 to 1.0% of aluminum.

[0013] Moreover, as for unleaded pewter of this invention, it is desirable as the component to contain 0.1 to 30% of In.

[0014] Furthermore, as for unleaded pewter of this invention, it is desirable as the component to contain 0.1 to 3.5% of Ag.

[0015] Furthermore, as for unleaded pewter of this invention, it is desirable as the component to contain 0.1 to 1.0% of Cu.

[0016] Furthermore, as for unleaded pewter of this invention, it is desirable as the component to contain 0.01 to 7.0% of Zn.

[0017] Moreover, as for unleaded pewter of this invention, it is desirable to contain one or more kinds of elements chosen from among Sb, Ti, and Si or Bi in a total of 10% or less of range.

[0018] Below, the Reason for composition limitation of unleaded pewter of this invention is explained. However, the following composition is displayed by weight %.

[0019] Since Sn has the operation of there being no toxicity and obtaining \*\*\*\* to a zygote, it is a component indispensable to pewter.

[0020] Although aluminum is an element which oxidizes very easily, there is an advantage of being easy to build combination in junction to an oxide. At less than 0.01%, the effect has low aluminum addition, when it exceeds 3.0%, while it is difficult for pewter's own hardness to secure increase and thermo-cycle-proof nature, a melting point is high, and workability gets worse. A more desirable addition is 0.01 to 1.0% of range.

[0021] In raises a wettability and it not only reduces the melting point of pewter, but it has the operation of making pewter itself soft. At less than 0.1%, the effect has low In addition, and if it exceeds 50%, pewter's own intensity reservation not only becomes difficult conversely, but it will become quite [ in cost ] expensive. The range of a more desirable addition is 0.1 to 30%.

[0022] Ag demonstrates the effect excellent in improvement in the mechanical strength of pewter by adding. At less than 0.1%, the effect has low Ag addition, and improvement in a mechanical strength is not obtained, but if it exceeds 6.0%, while a melting point will become high, an intermetallic compound with Sn occurs so much, and that a mechanical strength falls conversely poses a problem. The range of a more desirable addition is 0.1 to 3.5%.

[0023] Cu demonstrates the effect excellent in improvement in the mechanical strength of pewter by adding like above-mentioned Ag. If Cu addition exceeds 6.0%, while a melting point will become high like Ag, an intermetallic compound with Sn occurs so much, and that a mechanical strength falls conversely poses a problem. The range of a more desirable addition is 0.1 to 1.0%.

[0024] Zn is added by pewter in order to give the adhesive strength to oxide material, such as glass and Ceramics Sub-Division. If Zn addition exceeds 10.0%, the tendency which becomes weak becomes remarkable and pewter's is not desirable practically. The range of a more desirable addition is 0.01 to 7.0%, and the still more desirable range is 0.5 to 5.0%.

[0025] In unleaded pewter of this invention, one or more kinds of elements can be suitably added in

10% or less of range among Sb, Ti, and Si or Bi. Sb makes a soldering appearance good and increases creep resistance. Ti, Si, and Bi can make the wettability of pewter improve. moreover -- in addition -- even if it adds a little elements, such as Fe, nickel, Co, Ga, germanium, and P, -- the characteristics as pewter -- that is, it is unleaded and also soldering nature and a mechanical strength are raised -- things can be carried out.

[0026] In addition, unleaded pewter of this invention can be soldered direct to the difficulty soldering metal which has oxide layers, such as aluminum besides oxide material, such as glass and Ceramics Sub-Division, titanium, and zirconium. Moreover, when soldering to difficulty soldering material, it is desirable to use the equipment which can add supersonic vibration to pewter in the case of soldering.

[0027]

[Embodiment of the Invention] Hereafter, a concrete example is given and the embodiment of this invention is explained.

[0028] (Example 1-14) Using soda lime glass (50x50x3mm) as jointed material, on the sheet glass, dissolution adhesion of the unleaded pewter which consists of Table 1 and composition shown in 2 was carried out on the frequency of 60kHz using the ultrasonic soldering iron with which the trowel point vibrates, and the sample of this example was created. Each composition in front is a weight % display.

[0029] The exfoliation degree of unleaded pewter at the time of deleting with a knife the unleaded solder layer pasted up on the sheet glass surface performed adhesive evaluation of sheet glass and unleaded pewter. As for the thing and x mark with which O mark remained on sheet glass in the adhesive column in Table 1 and 2 without more than half of a solder layer exfoliating, all solder layers exfoliate.

[0030]

[Table 1]

	実施例 1	実施例 2	実施例 3	実施例 4	実施例 5	実施例 6	実施例 7	実施例 8	実施例 9	実施例 10
S n	62.2	63.95	45.5	88	85	70.5	50	67	76	65
A l	0.5	0.05	2.5	0.5	0.5	1	2.5	0.5	0.5	1
I n	30	28	40	1	10	26	45	30	15	28
A g	2.3	2.5	2.5	3.5	3	2	1.5	0.5	6	2.3
C u	0	0	0	0	0	0	0	0	0.5	0.7
Z n	5	5.5	9.5	7	1.5	0.5	1	2	2	3
合計	100	100	100	100	100	100	100	100	100	100
接着性	○	○	○	○	○	○	○	○	○	○

[0031]

[Table 2]

	実施例11	実施例12	実施例13	実施例14	比較例1	比較例2	比較例3
S n	65	69	64	68	77.2	70	96.5
A l	0.5	0.5	1	0.95	0	0	0
I n	26	26	28	28.4	20	0	0
A g	2.5	0.5	2	2.5	2.8	0	3.5
C u	5	3	2	0.05	0	1	0
Z n	1	1	3	0.1	0	29	0
合計	100	100	100	100	100	100	100
接着性	○	○	○	○	×	×	×

[0032] So that clearly from Table 1 and 2 [ the sample of this example ] By making components, such as aluminum, In, Zn, and Ag, Cu, contain appropriately, as shown in Claim 1 Since it not only increases bond strength with glass, but has various characteristics required in order to paste up firmly pewter, such as pewter's own mechanical strength and distortion relief of the glass pewter interface at the time of cooling, and glass, Glass can be firmly joined with pewter and the problem of exfoliation by the shock after soldering etc. is not produced at all.

[0033] (Comparative examples 1 to 3) The composition and the adhesive property of a comparative example over this invention are shown in Table 2. Composition is a weight % display.

[0034] The addition of aluminum of comparative examples 1 to 3 is all outside the range of this invention, and the addition of In is outside the range of this invention a comparative example 2 and 3 further. For this reason, in unleaded pewter of a comparative example, bond strength with sheet glass is low, and all solder layers have exfoliated.

[0035] (Example 15-24) Using soda lime glass (50x50x3mm) as jointed material, on the sheet glass, dissolution adhesion of the unleaded pewter which consists of composition shown in Table 3 was carried out on the frequency of 60kHz using the ultrasonic soldering iron with which the trowel point vibrates, and the sample of this example was created. Each composition in front is a weight % display.

[0036] The exfoliation degree of unleaded pewter at the time of deleting with a knife the solder layer pasted up on the sheet glass surface like the case of said example 1-14 performed adhesive evaluation of sheet glass and pewter. As for the thing and x mark with which O mark remained on sheet glass in the adhesive column in Table 3 without more than half of a solder layer exfoliating, all solder layers exfoliate.

[0037]

[Table 3]

	実施例15	実施例16	実施例17	実施例18	実施例19	実施例20	実施例21	実施例22	実施例23	実施例24
S n	56	72	66	59	55	64	68	57	64	67.5
A l	1	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
I n	28	18	28	30	40	28	28	38	28	28
A g	2	2	2.5	2.5	2.45	2.45	2.45	2.45	2	2
C u	0	0	0	0	0	0	0	0	0	0
Z n	5	2	1	3	2	5	1	1.55	5	2
S b	5	0	2	0	0	0	0	0	0	0
T l	3	0	0	0	0	0	0	0	0	0
S i	0	2	0	0	0	0	0	0	0	0
B i	0	3	0	5	0	0	0	0	0	0
F e	0	0	0	0	0.05	0	0	0	0	0
N i	0	0	0	0	0	0.05	0	0	0	0
C o	0	0	0	0	0	0	0.05	0	0	0
G a	0	0	0	0	0	0	0	0.5	0	0
G e	0	0	0	0	0	0	0	0	0.05	0
P	0	0	0	0	0	0	0	0	0	0.001
合計	100	100	100	100	100	100	100	100	100	100.001
接着性	○	○	○	○	○	○	○	○	○	○

[0038] So that clearly from Table 3 [ the sample of this example ] By adding appropriately a component as shown in Claim 7 besides the component shown in Claim 1 and Fe, nickel, Co, Ga, germanium, and the minute amount addition ingredient of P Since it not only increases bond strength with glass, but has various characteristics required in order to paste up firmly pewter, such as pewter's own mechanical strength and distortion relief of the glass pewter interface at the time of cooling, and glass, Glass can be firmly joined with pewter and the problem of exfoliation by the shock after soldering etc. is not produced at all.

[0039]

[Effect of the Invention] As explained above, unleaded pewter of this invention does not contain lead of a toxic substance. By adding appropriately a component as contained the component shown in Claim 1 and shown in Claim 7 and Fe, nickel, Co, Ga, germanium, and the minute amount addition ingredient of P Since it not only increases bond strength with glass, but has various characteristics required in order to paste up firmly pewter, such as pewter's own mechanical strength and distortion relief of the glass pewter interface at the time of cooling, and oxide material, such as glass, Oxide material, such as glass and Ceramics Sub-Division, can be firmly joined with pewter, and it has the outstanding effect of moreover being hard to produce exfoliation after soldering.

[Translation done.]